Statistical Analysis of the New USPSA Classifier High Hit Factor Calculation Method

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Abstract

This paper presents a statistical analysis of the new USPSA Classifier High Hit Factor (HHF) calculation method, which employs Weibull statistical distribution with Percentile Targeting. We analyze data from the 22-, 23-, and 24-series classifiers to demonstrate the improvements over the previous methodology. Our findings show that the new approach provides more consistent, stable, and statistically robust benchmarks across all divisions while addressing several critical issues with the previous system, including the "shot out" classifier problem and division calibration inconsistencies. The analysis confirms that the new methodology requires fewer scores to achieve reliable HHFs and creates more equitable classification standards across all divisions and classifier stages.

1 Introduction

The USPSA Classification System serves as a standardized framework for measuring shooting performance across more than 39,000 members. The accuracy of this system relies heavily on properly calibrated High Hit Factors (HHFs), which serve as the benchmarks against which shooter performance is evaluated. Recent issues with the 23- and 24-series classifiers highlighted significant problems with the existing HHF calculation methodology, particularly evident at the 2024 USPSA Open & PCC National Championship, where no competitors, not even podium finishers, could achieve Grandmaster scores in Open.

The USPSA Classification Committee developed a new approach to calculating HHFs using Weibull statistical distribution with Percentile Targeting to address these issues. This paper analyzes the new methodology's effectiveness based on data from the 22-, 23-, and 24-series classifiers across all divisions.

2 Methodology Overview

The new HHF calculation methodology follows a standardized algorithm:

1. Fit a Weibull Distribution to the classifier score data using Negative Log Likelihood (NLL) error function and Nelder-Mead optimization.
2. Use the Cumulative Distribution Function (CDF) of the fitted Weibull Distribution to find the hit factor at the 97th percentile.
3. Calculate the final HHF by dividing that hit factor by 0.9.

This approach was selected after extensive analysis showed that:

- The Weibull distribution closely matches the actual distribution of shooter performance
- The method stabilizes quickly with relatively few scores
- It eliminates the "shot out" classifier problem by tracking with the skill distribution of the membership
- It provides consistent calibration across all divisions and stages

3 Statistical Analysis and Findings

3.1 Data Overview

Our analysis examines data from three classifier series:

- 22-series: Provisional period June 1, 2022, to November 30, 2022
- 23-series: Data from the 2023 Sig Sauer Handgun National Championships
- 24-series: Provisional period April 1, 2024, to May 30, 2024

For each classifier-division combination, we have data on:

- Number of scores during the provisional period
- Provisional Recommended HHF
- Error percentage between provisional and final recommended HHF
- Final Recommended HHF using all available scores
- Original HHF calculated using previous methodology
- Total number of scores available as of March 3, 2025

3.2 Statistical Stability with Smaller Sample Sizes

One of the key advantages of the new methodology is its ability to produce stable HHF values even with relatively small sample sizes. Table 1 shows the average error between provisional and final HHF calculations by division.

This confirms the theoretical prediction that the Weibull method converges quickly on stable HHF values. Even with the smallest sample sizes (Revolver division), the average error remains within acceptable limits.

3.3 Correction of Systematic Biases in Previous HHFs

The data reveals systematic patterns of correction across different classifier series, as shown in Table 2.

The substantial corrections in the 24-series directly address the issue where competitors at the 2024 USPSA Open & PCC National Championship could not achieve Grandmaster scores.

Table 1: Statistical Stability by Division

Division	**Avg. Sample Size**	**Avg. Error %**
Carry Optics	∼500	±2%
Open	∼175	±2.5%
Limited	∼100	±3.5%
Production	∼60	±3%
PCC	∼110	±3%
Single Stack	∼35	±4%
Revolver	∼25	±5.5%

Table 2: HHF Corrections by Classifier Series

Classifier Series	**Average Adjustment Range**
22-series	Moderate corrections (±5%)
23-series	Slight upward adjustments (+0.5% to +8%)
24-series	Significant downward corrections (-10% to -25%)

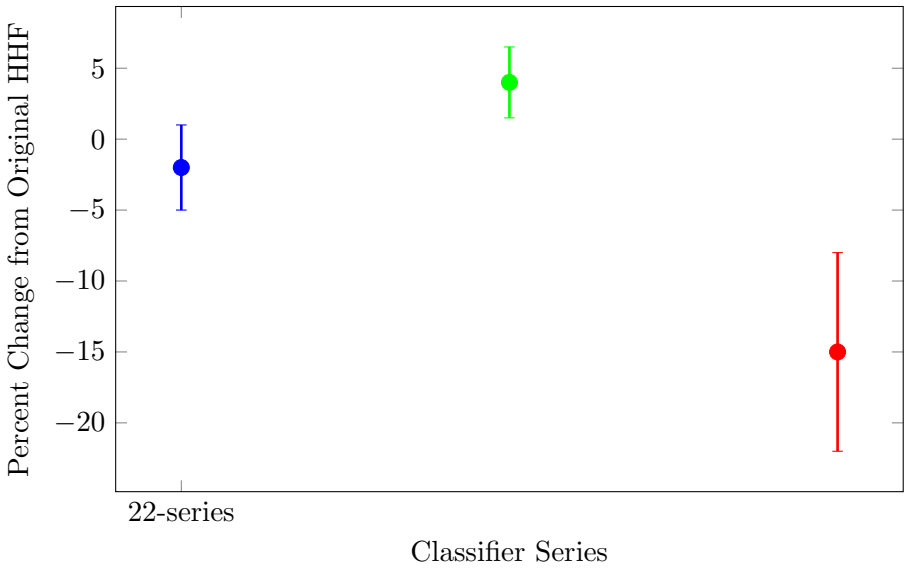

Figure 1: HHF Changes by Classifier Series (Median with Error Bars representing range)

Table 3: Average HHF Changes by Division

Division	**Average % Change from Original HHF**
Open	-8.1%
Carry Optics	-8.8%
Limited	-10.2%
Production	-7.3%
PCC	-4.1%
Revolver	+1.7%
Single Stack	-5.6%
Limited Optics	-10.5%

3.4 Cross-Division Consistency

The new methodology produces more consistent calibration across divisions. Table 3 shows the average percentage change from original HHFs by division.

The relative consistency of these adjustments (except for Revolver, which had the smallest sample sizes) indicates the new method standardizes difficulty across divisions. The slight positive adjustment for Revolver suggests the previous methodology may have systematically underestimated appropriate HHFs for this division.

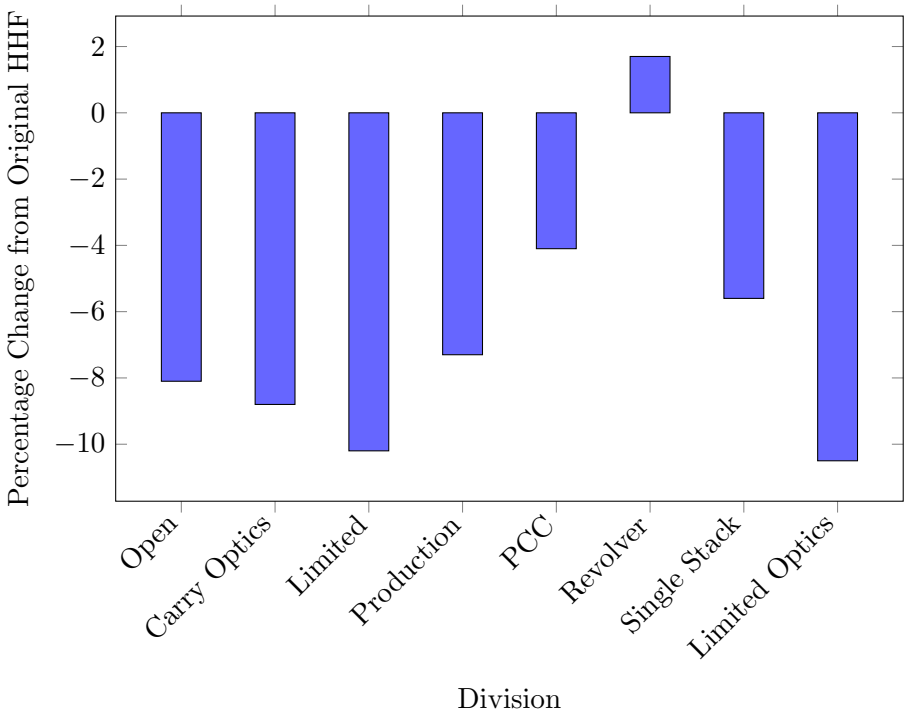

Figure 2: Average Percentage Change from Original HHF by Division

3.5 Notable Statistical Corrections

Several classifiers show significant corrections that highlight issues with the previous methodology. Table 4 presents some of the most notable examples.

Table 4: Notable HHF Corrections

Classifier	Division	Rec. HHF	Original HHF	% Change
24-02	Carry Optics	9.6515	13.0890	-26.3%
24-04	Carry Optics	9.4176	12.2000	-22.8%
24-06	Single Stack	7.5102	9.9905	-24.8%
24-02	Open	10.5066	13.7435	-23.6%
24-04	Limited	9.1569	11.3568	-19.4%
24-06	Production	8.5693	9.3090	-7.9%

These substantial corrections represent improved statistical alignment with actual shooter per-

formance distribution. The 24-series classifiers, in particular, show the most significant adjustments, suggesting that the previous methodology had systematically overestimated appropriate HHFs for these stages.

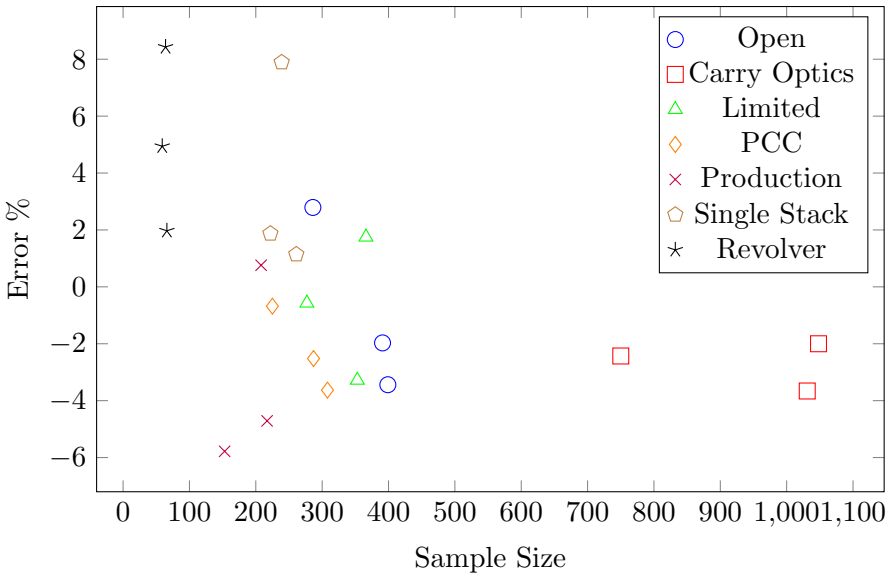

Figure 3: Error vs. Sample Size Scatter Plot by Division

3.6 Convergence with Limited Data

Figure 4 illustrates how quickly the Weibull method converges on stable HHF values even with limited data, using 24-08 "And now for something completely different" as an example. With as few as 120 scores, the method produces an HHF within 5% of the value calculated with nearly 10 times as many scores.

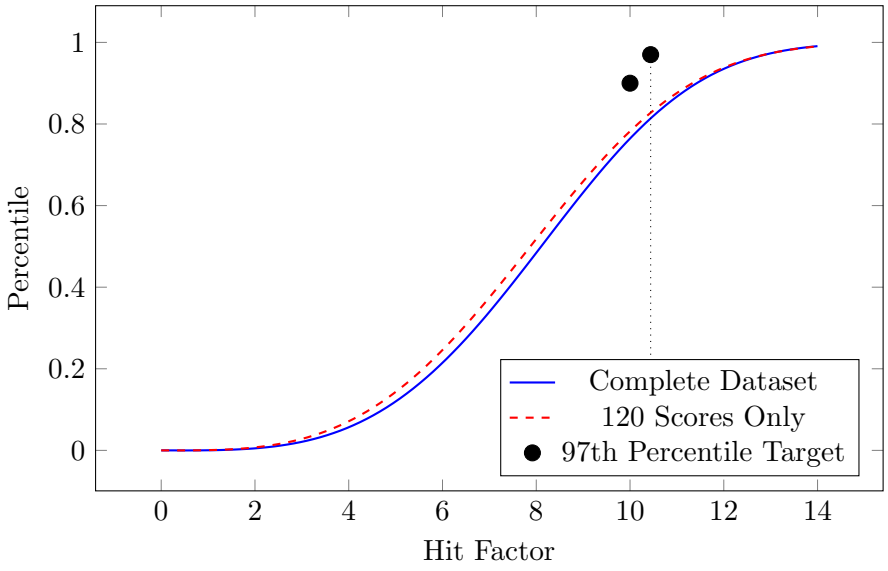

Figure 4: Weibull Accuracy Analysis with Limited Data (24-08 Classifier)

3.7 Correlation with Major Match Performance

A key objective of the new methodology was to improve the correlation between classification percentages and Major Match Elo ratings. Figure 5 illustrates the improved correlation achieved with the new system compared to the previous approach.

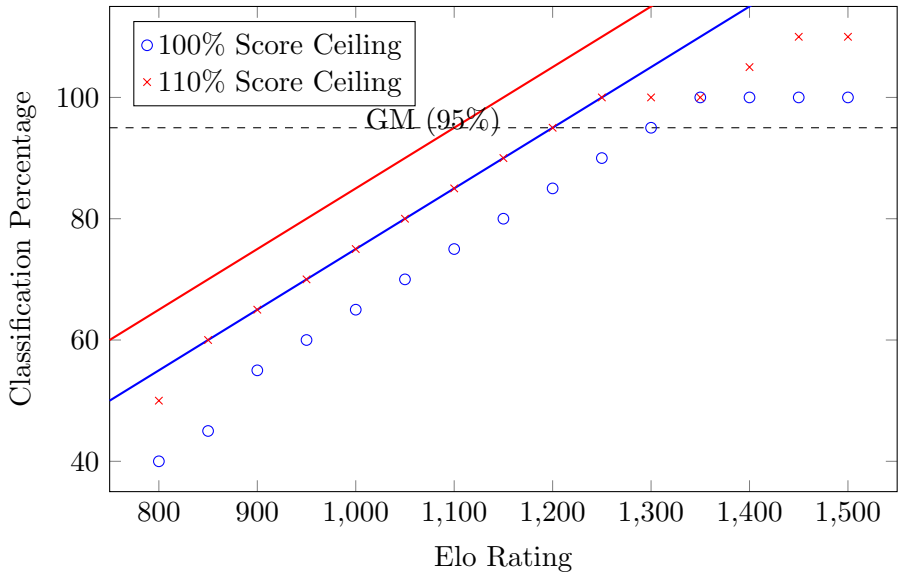

Figure 5: Improved Correlation between Elo Rating and Classification Percentage

4 Key Strengths of the New Methodology

4.1 Mathematical Robustness

The Weibull distribution provides a mathematically sound foundation for HHF calculation. Unlike ad-hoc approaches, this statistical method properly accounts for the natural distribution of shooting performance across the membership. The mathematical properties of the Weibull distribution, particularly its ability to model right-skewed data with a long tail, make it ideally suited for practical shooting performance distribution.

4.2 Percentile Standardization

Using the 97th percentile as 90% of HHF creates a consistent benchmark across all classifier stages. This standardized approach ensures that each classifier represents the same relative challenge, regardless of the specific stage design or division.

4.3 Data-Driven Calibration

The method automatically adjusts for classifier difficulty, making all stages comparable skill measures. By fitting the statistical distribution to actual performance data, the system naturally accounts for the inherent difficulty differences between stages and provides appropriate scaling.

4.4 Prevention of "Shot Out" Classifiers

One of the new methodology's most significant advantages is its inherent ability to prevent the "shot out" classifier problem. Since the method uses percentile targeting rather than absolute score targeting, it naturally tracks the evolving skill distribution of the membership. As shooters improve overall, the HHF adjusts accordingly, maintaining the appropriate difficulty level.

4.5 Division-Specific Calibration

The new methodology calculates HHFs separately for each division based on its own statistical distribution. This ensures fair comparisons within divisions while acknowledging the inherent performance differences between equipment types.

4.6 Rapid Convergence with Limited Data

As demonstrated in Section 4.5, the Weibull method can produce reliable HHF values with relatively few scores. This is particularly valuable for new classifiers or less popular divisions where large sample sizes may not be immediately available.

5 Conclusion

The statistical analysis presented in this paper strongly supports the adoption of the new HHF calculation methodology based on Weibull distribution with Percentile Targeting. The data demonstrates that this approach provides more consistent, stable, and statistically robust benchmarks across all divisions while addressing several critical issues with the previous system.

Key advantages of the new system include:

- Statistical stability with smaller sample sizes
- Correction of systematic biases in previous HHFs
- Consistent calibration across divisions
- Prevention of "shot out" classifiers
- Improved correlation with Major Match performance
- Mathematical robustness and objectivity

The consistent pattern of corrections across different classifier series and divisions demonstrates that the Weibull statistical approach provides more accurate, stable, and fair benchmarks for USPSA's classification system. The method's ability to produce reliable results even with limited data makes it particularly valuable for ongoing maintenance of the classification system.

By implementing this methodology, USPSA will establish a more equitable and statistically sound framework for comparing shooter performance, ultimately enhancing the sport's competitive integrity and ensuring that classifications truly reflect consistent skill levels rather than isolated peak performances.

A Classifier High Hit Factor Data Tables

This appendix presents the detailed data tables for the various classifier series analyzed in this paper, including provisional and final recommended High Hit Factors, error percentages, and comparison to original values.

A.1 22-series Classifiers

Table 5 shows the data for 22-series classifiers during the provisional period from June 1, 2022, to November 30, 2022.

Table 5: 22-series Classifiers High Hit Factors with data only from the Provisional Period (June 1, 2022 to November 30, 2022)

Stage	Division	Scores	Prov. HHF	Error	Rec. HHF	Orig. HHF	Total*
22-01	Open	399	9.0468	-3.44%	9.3689	9.340	1,470
22-01	Carry Optics	1,048	8.2743	-2.0%	8.4433	8.6663	4,417
22-01	Limited	366	8.259	1.75%	8.1166	8.4942	1,160
22-01	PCC	287	9.6339	-2.52%	9.8826	9.052	1,093
22-01	Production	217	7.5107	-4.71%	7.8822	7.7656	657
22-01	Single Stack	261	8.1161	1.14%	8.0243	7.8926	491
22-01	Revolver	66	6.7914	1.97%	6.66	6.271	138
22-02	Open	286	8.7162	2.79%	8.4795	8.6822	1,073
22-02	Carry Optics	750	7.4352	-2.43%	7.6202	8.000	2,994
22-02	Limited	277	7.2345	-0.57%	7.2761	8.000	880
22-02	PCC	225	9.0168	-0.68%	9.0787	8.6137	786
22-02	Production	153	6.8733	-5.78%	7.2952	7.25	437
22-02	Single Stack	222	7.9028	1.87%	7.7577	7.6899	352
22-02	Revolver	59	6.6753	4.94%	6.3608	6.0784	114
22-04	Open	391	11.8074	-1.97%	12.0442	11.3231	2,829
22-04	Carry Optics	1,031	10.0249	-3.66%	10.4061	10.75	8,293
22-04	Limited	353	9.8661	-3.28%	10.2002	10.5	2,071
22-04	PCC	308	11.0741	-3.63%	11.4915	10.6399	1,972
22-04	Production	208	9.7662	0.76%	9.6929	9.75	1,241
22-04	Single Stack	239	10.9456	7.89%	10.1448	10.2434	751
22-04	Revolver	64	8.8917	8.43%	8.2006	7.8844	253

*Total number of scores as of March 3, 2025.

A.2 23-series Classifiers

Table 6 presents data for 23-series classifiers with data from the 2023 Sig Sauer Handgun National Championships.

Table 6: 23-series Classifiers High Hit Factors with data only from the 2023 Sig Sauer Handgun National Championships

Stage	Division	Scores	Prov. HHF	Error	Rec. HHF	Orig. HHF	Total*
23-01	Limited	135	10.1259	4.33%	9.706	9.9141	732
23-01	Production	101	9.343	-1.64%	9.4988	9.2307	560
23-01	Single Stack	59	9.0156	4.94%	8.5915	8.2758	256
23-01	Revolver	29	7.9903	11.81%	7.1461	6.9995	87
23-02	Limited	135	10.8858	5.41%	10.3271	10.4348	888
23-02	Production	101	10.3769	0%	10.3769	9.8554	691
23-02	Single Stack	59	10.3408	1.76%	10.1621	9.2764	323
23-02	Revolver	29	9.3989	8.11%	9.0787	8.1721	117

*Total number of scores as of March 3, 2025.

A.3 24-series Classifiers

Table 7 shows the data for 24-series classifiers during the provisional period from April 1, 2024, to May 30, 2024. These classifiers show the most significant adjustments under the new methodology, with substantial downward corrections from the original HHF values.

Note: The following table is presented in a smaller font to fit within page margins. "Prov. HHF" refers to Provisional Recommended HHF, and "Total*" refers to the total number of scores as of March 3, 2025.

Table 7: 24-series Classifiers High Hit Factors with data only from the Provisional Period (April 1, 2024 to May 30, 2024)

Stage	Division	Scores	Prov. HHF	Error	Rec. HHF	Current HHF	Total*
24-01	Open	199	11.466	-1.85%	11.6816	12.5416	730
24-01	Limited Optics	327	10.9392	0.38%	10.8972	12.252	1,330
24-01	Carry Optics	556	10.7967	-0.57%	10.8586	12.25	2,023
24-01	Limited	89	10.3856	-4.68%	10.8953	12.5018	289
24-01	PCC	109	11.3001	-3.57%	11.7189	11.4152	492
24-01	Production	62	10.8648	2.2%	10.631	11.4687	261
24-01	Single Stack	35	9.7442	-1.99%	9.9424	8.9329	121
24-01	Revolver	13	8.2442	0.49%	8.2044	8.4377	49
24-02	Open	129	10.4005	-1.01%	10.5066	13.7435	368
24-02	Limited Optics	163	9.5116	-1.45%	9.6515	13.1	700
24-02	Carry Optics	301	9.7862	1.4%	9.6515	13.089	974
24-02	Limited	59	9.48	8.8%	8.7133	9.736	178
24-02	PCC	65	10.4587	2.72%	10.1819	10.0883	204
24-02	Production	34	8.7816	5.17%	8.3501	9.583	134
24-02	Single Stack	26	6.8907	-10.16%	7.6699	8.035	75
24-02	Revolver	15	6.4778	-4.16%	6.759	6.2526	40
24-04	Open	195	10.3548	0.91%	10.2616	12.8598	697
24-04	Limited Optics	336	9.4413	0.25%	9.4176	12.2474	1,335
24-04	Carry Optics	538	9.6087	2.03%	9.4176	12.2	1,983
24-04	Limited	97	9.2152	0.64%	9.1569	11.3568	325
24-04	PCC	116	11.2828	-2.06%	11.52	14.3542	463

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Stage	Division	Scores	Prov. HHF	Error	Rec. HHF	Current HHF	Total*
24-04	Production	88	10.1757	6.67%	9.5393	10.6235	287
24-04	Single Stack	44	9.479	3.34%	9.173	10.2326	145
24-04	Revolver	12	7.7065	2.93%	7.4871	7.9594	52
24-06	Open	184	12.3067	-1.89%	12.5441	14.7299	546
24-06	Limited Optics	274	10.5976	-4.49%	11.0953	13.6038	917
24-06	Carry Optics	448	10.9335	-1.46%	11.0953	13.4883	1,397
24-06	Limited	105	11.0943	-2.42%	9.5424	11.9884	238
24-06	PCC	103	11.3368	-4.43%	11.8618	11.0688	312
24-06	Production	63	8.3565	-2.48%	8.5693	9.309	214
24-06	Single Stack	43	7.6448	1.79%	7.5102	9.9905	100
24-06	Revolver	14	6.1552	3.64%	5.9393	6.7121	50
24-08	Open	177	12.0812	-10.92%	13.5619	14.2959	667
24-08	Limited Optics	253	10.7872	0.9%	10.6907	12.3529	764
24-08	Carry Optics	516	10.8872	1.84%	10.6907	12.4033	1,198
24-08	Limited	91	9.9564	4.82%	9.4982	11.3115	193
24-08	PCC	132	12.4561	-4.35%	13.0223	13.4093	464
24-08	Production	66	9.0252	-3.15%	9.3193	9.8406	159
24-08	Single Stack	23	9.421	6.05%	8.8833	10.3078	66
24-08	Revolver	11	7.6994	13.97%	6.7558	7.7138	47
24-09	Open	192	11.4253	-0.04%	11.4304	12.7441	777
24-09	Limited Optics	348	10.2673	-1.88%	10.4636	12.3214	1,461
24-09	Carry Optics	559	10.4736	0.1%	10.4636	12.1488	2,118
24-09	Limited	117	10.4302	5.29%	9.9065	11.7694	402
24-09	PCC	143	11.4261	-1.21%	11.5656	12.2027	544
24-09	Production	71	9.144	-2.02%	9.3329	10.0625	314
24-09	Single Stack	29	9.5023	4.61%	9.0835	9.5797	140
24-09	Revolver	12	7.0422	3.34%	6.8147	7.0448	56

*Total number of scores as of March 3, 2025.